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PSEUDODONTORNIS AND OTHER LARGE MARINE BIRDS FROM THE MIOCENE OF SOUTH CAROLINA

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INTRODUCTION

While engaged in the reorganization[1] of the vertebrate fossil collections at the Peabody Museum of Natural History, Yale University, the writer discovered the incomplete lower jaw of a large bird from the Miocene phosphate deposits near Charleston, South Carolina. The specimen is clearly referable to the family Pseudodontornithidae, an extinct group of very large oceanic birds characterized by the presence of vertical bony tooth-like processes, or, as the family name implies, pseudoteeth, on the margins of their jaws. This is the first record of a pseudotoothed bird from eastern North America.

The only previously described bird from these deposits is *Palaeochenoides mioceanus* (Schufeldt, 1916) represented by a partial femur. A further search made in the collection of phosphate beds fossils at Yale for additional avian material yielded negative results. Professor Bryan Patterson called my

[1] Research reorganization of this collection was supported by National Science Foundation grant GB-247 (1962).

attention to a large undescribed tarsometatarsus from the phosphate beds which is in the Museum of Comparative Zoology at Harvard. Dr. Pierce Brodkorb later informed me of a second undescribed tarsometatarsus from the Cooper River near Charleston; this specimen is in the collections of the United States National Museum.

These two specimens and the recently discovered dentary are described in this paper. The possibility that the two tarsometatarsi and the femur described as *Palaeochenoides* might belong to members of the family Pseudodontornithidae is assessed.

ACKNOWLEDGMENTS

Thanks are due Professor Bryan Patterson for bringing to my attention the existence of the tarsometatarsus in the Museum of Comparative Zoology and to Dr. Ernst Mayr for permission to borrow and describe it.

Dr. Alexander Wetmore of the United States National Museum very generously allowed me to borrow and describe the tarsometatarsus from that institution. Dr. Wetmore's kindness in turning over to me his notes on this specimen, to which he had already devoted considerable study, is also gratefully acknowledged.

Dr. Hildegarde Howard supplied me with a mold of the foot of *Osteodontornis orri*. Dr. Howard and Dr. Pierce Brodkorb provided information on fossil and recent birds not available in the literature and offered useful criticism of the manuscript. Dr. John H. Ostrom and Dr. Elwyn L. Simons also gave welcome advice and criticism.

ABBREVIATIONS

MCZ—Museum of Comparative Zoology, Harvard University, Cambridge.

USNM—United States National Museum, Washington.

YPM—Peabody Museum of Natural History, Yale University, New Haven.

PREVIOUS KNOWLEDGE OF PSEUDOTOOTHED BIRDS

The only previously described pseudotoothed bird of definite North American provenance is *Osteodontornis orri* from the Upper Miocene of California (Howard, 1957). The type specimen of this species consists of a crushed skull and lower jaws, relatively complete though crushed wing and leg bones, several caudal vertebrae, and the impressions of a number of wing feathers. It is by far the most complete pseudotoothed bird specimen known, but its damaged state makes many areas of its anatomy extremely difficult to interpret. Howard estimates the wingspread of the living bird to have been over 16 feet. A second specimen of *O. orri* from California, consisting of fragmentary upper and lower jaws and a partial, though uncrushed, atlas, was later described by Howard and White (1962).

A closely related form, *Pseudodontornis longirostris*, had earlier been described by Spulski (1910) and redescribed by Lambrecht (1930). This form is known from a skull and right lower jaw which had been purchased in 1905 by the Zoological Institute of Königsberg, Germany, from a Brazilian sailor. No locality or age data were ever obtained for this specimen; it is possibly from Brazil, but this is far from certain. In size, the type skull is only slightly larger than that of *Osteodontornis orri*.

A third, more distantly related, "toothed" bird, about half the size of the above forms, has long been known from the Eocene London Clay. This is *Odontopteryx toliapica*, described by Sir Richard Owen in 1873 from an incomplete skull and jaws. It is currently placed in the monotypic family Odontopterygidae. The most obvious distinguishing feature between *Odontopteryx* and the pseudodontorns is that the "teeth" in the former slant forward, while those in the latter stand perpendicular to the margin of the jaw. The three genera are usually grouped as the suborder Odontopterygia of the Order Pelecaniformes (Brodkorb, 1963), though Howard (1957) believes they merit separate ordinal rank.

AGE OF THE PHOSPHATE BEDS BIRDS

In the nineteenth century, abundant vertebrate fossils were dredged from the beds of coastal rivers in the vicinity of Charleston, South Carolina, during the course of commercial phosphate digging. The phosphate deposits have long been recognized to contain a mixture of fossils ranging from Miocene to Pleistocene ages. The remains of land mammals are almost wholly from the Pleistocene, though a few are clearly of Pliocene and even Miocene ages (Allen, 1926; Simpson, 1932). The marine fossils—cetaceans, sirenians, bony fishes, and sharks—seem to be mainly Miocene in aspect, though mixing here too cannot be ruled out. One sirenian, *Halitherium alleni*, is referred to a genus which is not known above the Lower Miocene in Europe (Simpson, 1932).

That part of the phosphate deposits which is of Miocene age is now considered to be a northern extension of the Hawthorne Formation of Florida (Wilmarth, 1938). Brodkorb (1963a) summarizes the evidence for considering the Hawthorne Formation to be of late Early Miocene age. The phosphate beds marine fauna is not known to cast doubt on this age determination. The birds described here are almost certainly part of this fauna and, therefore, may be considered at least tentatively to be of late Early Miocene age.

DESCRIPTION AND DISCUSSION OF MATERIAL

Family PSEUDODONTORNITHIDAE Lambrecht

Pseudodontornis longirostris (Spulski)
Figure 1A

Odontopteryx longirostris Spulski, 1910, p. 507.

Pseudodontornis longirostris, Lambrecht, 1930, p. 1.

This specimen (YPM 4617) consists of a portion of the anterior half of a right dentary bearing three prominent teeth[2] and the remnants of several smaller ones. It is from the large C. A. Scanlon collection of phosphate beds fossils which was acquired by Yale Peabody Museum in 1913. No locality data on the Scanlon collection exists in Peabody

[2] Although these tooth-like processes are not true teeth, the quotation marks will be omitted in the rest of the discussion.

Museum records other than the very general: "Phosphate diggings about Charleston, S.C." However, Shufeldt (1916, p. 344), with reference to the type locality of *Palaeochenoides*, quotes a letter from Dr. Earle Sloan of Charleston which states, "The Scanlon collection was in the main taken from the rock dredged from the bed of the Stono River near its source."

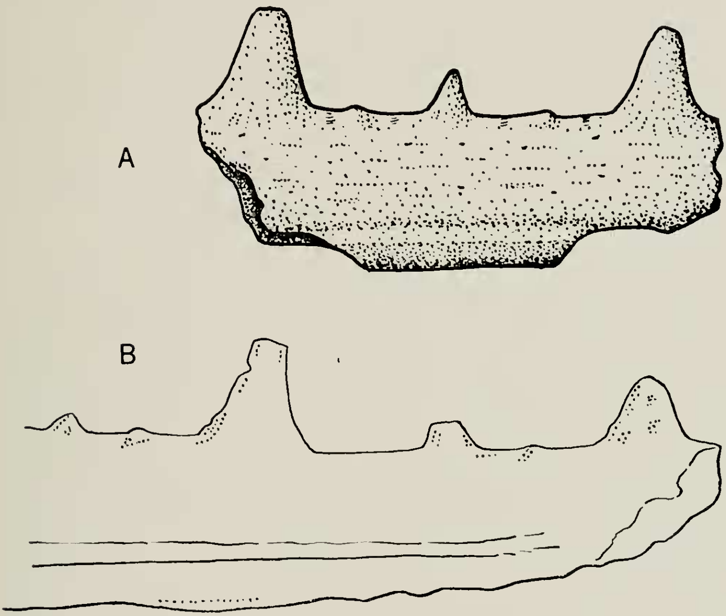

Figure 1. Lateral views of right dentaries of *Pseudodontornis longirostris*. A. YPM 4617. B. Type, from Lambrecht, 1930. Both ×1.

Howard (1957) cites as distinguishing features between the dentaries of the two larger genera of pseudotoothed birds the following characteristics: in *Osteodontornis* there are "two or three smaller 'teeth' between each large one on [the] lower jaw"; in *Pseudodontornis* there is "only one smaller 'tooth' between large ones on [the] lower jaw." In number and arrangement of teeth, the Hawthorne dentary corresponds more closely to Howard's characterization of *O. orri*, but I believe the "dental" distinctions which she cites are not valid.

Neither Spulsky (1910) nor Lambrecht (1930) made any reference to more than a single tooth between the large teeth in the type of *P. longirostris*, but Lambrecht's photograph of the type dentary (Pl. II, Fig. 2), which is redrawn in Fig. 1B, shows a very low rounded protuberance midway between the first and second teeth and another between the third and fourth teeth. These protuberances are identical in appearance to the broken bases of similarly placed small teeth in the Hawthorne specimen and presumably represent the remnants of formerly complete tooth-like projections. It seems likely that in a well-preserved jaw of *Pseudodontornis* the number and distribution of teeth would probably be very similar to that which Howard (1957) believes to be diagnostic of *Osteodontornis*. Therefore, in identifying the Hawthorne jaw I have utilized as diagnostic characters only the gross size of the specimen and the sizes of and distances between the preserved teeth.

The anterior tip of the dentary is unfortunately not preserved in either described specimen of *O. orri*. Howard's measurements on the more posterior portions of the type mandibles show that: (1) large teeth are spaced 30-40 mm apart; (2) large teeth range from 7.5 to 13 mm in height and 7.5 to 10 mm in basal length; and (3) the largest tooth is the third from the back (Howard, 1957, p. 12). The measurements of the Hawthorne jaw are given in Table 1. The two large teeth are comparable in size to the largest tooth in *O. orri* but are about 5 mm higher and longer than the smallest tooth of the large size class. The distance between the two large teeth in the Hawthorne jaw is almost 12 mm greater than the maximum distance in *O. orri*.

Examination of Lambrecht's figure (1930, Pl. II, Fig. 2) as redrawn in Fig. 1B, indicates that the teeth of *P. longirostris* are, on the average, larger than those of *O. orri*. Also, the distance between the teeth is greater (by about 10 mm), though Howard (1957, p. 12) states that the distance is about the same in the two species. A comparison of the Hawthorne jaw (Fig. 1A) and the comparable region of the type dentary of *P. longirostris* (Fig. 1B) indicates that they are remarkably similar, especially in the distances between the preserved teeth. On this basis, YPM 4617 is referred to this genus and species.

Table 1

MEASUREMENTS ON YPM 4617 IN MM

Preserved Length	68.1
Maximum Depth	20.4
Width:	
Below Anterior "Tooth"	9.0
Below Posterior "Tooth"	10.1
Distance Between Two Largest "Teeth"	51.9
Distance Between Middle and Posterior "Teeth"	24.5
Anterior "Tooth":	
Height	12.5
Length at Base	12.0
Posterior "Tooth":	
Height	12.2
Length at Base	12.8
Middle "Tooth":	
Height	5.4
Length at Base	6.8

The discovery of *Pseudodontornis longirostris* in the Hawthorne Formation of South Carolina establishes a Miocene age for this species and strengthens the supposition that the type specimen came from the Western Hemisphere. It does not, however, demonstrate that the type was necessarily from North America, for a large oceanic bird of this sort was probably widely distributed.

The fragmentary Hawthorne specimen is undoubtedly from near the anterior end of the jaw for it is dorsoventrally very shallow. Low on its lateral surface is a shallow longitudinal sulcus which is characteristic of the three known species of "toothed" birds. In cross section the outer surface of the jaw is straight and vertical, the inner surface smoothly convex. The three largest teeth have straight sides which are continuous with the sides of the jaw. They are inclined somewhat laterally so that their tips are directly above the outer margin of the jaw. The bases of the smaller teeth are restricted to the lateral half of the jaw margin.

The preserved "dentition" consists of two large teeth 51.9 mm apart and a single smaller tooth about midway between them (actually 24.5 mm from the posterior large tooth). Halfway between the middle tooth and each of the larger teeth are the broken bases of two even smaller teeth. Finally, in each of the spaces between these five teeth are shiny oval patches, flush with the jaw margin, which are the bases of four very tiny teeth of which no remnant is preserved. These teeth correspond to the "narrow spinelike ridges" in the lower jaw of the second specimen of *Osteodontornis* (Howard and White, 1962).

The outer surfaces of the teeth bear longitudinal striations and small foramina. The foramina undoubtedly represent Volkman canals, seen in the thin sections of a tooth of *O. orri* (Howard, 1957, p. 10, fig. 5).

A transverse break at midheight across the anterior large tooth shows that this structure is hollow, with walls about 1.0 mm in thickness. Several thin bony trabeculae extend into the central cavity from the walls and the break cuts across one trabecula in the center of the cavity. This conflicts with the findings of Lambrecht (1930) who states that X rays showed that the teeth in the type of *P. longirostris* are not hollow but are composed of spongy bone. The teeth of *O. orri* are hollow and much like the one described here (Howard, 1957), and in *Odontopteryx* certain teeth are described as being hollow (Owen, 1873). Inasmuch as Lambrecht did not examine sections across the teeth of *Pseudodontornis*, his statement that the teeth in this form are not hollow requires further confirmation before it can be accepted.

Family CYPHORNITHIDAE? Wetmore

?*Palaeochenoides mioceanus* Shufeldt

Figure 2

This well-preserved distal portion of a left tarsometatarsus (MCZ 2514) is from the William Pringle Frost collection of phosphate beds fossils which is now in the Museum of Comparative Zoology at Harvard. A number of fossil mammals from the Frost collection were described by Allen (1926). He states that this collection is from the Ashley River. The marine forms, including the present specimen, are almost certainly from the Hawthorne Formation.

With the exception of the above-described specimen of *Pseudodontornis*, the only bird previously known from the Hawthorne Formation of South Carolina is *Palaeochenoides mioceanus*, described by Schufeldt (1916) from the distal end of a right femur. Shufeldt believed the affinities of this species to be with the anseriforms, but Wetmore (1917) subsequently pointed out that the type femur is distinctly pelecaniform in morphology. This element indicates that *Palaeochenoides* was a very large bird, being, according to Wetmore, somewhat larger than the living *Pelecanus onocrotalus* or *P. erythrorhynchus*. Wetmore (1928) later allied *Palaeochenoides* with *Cyphornis*, a gigantic Lower Miocene bird, known only from the proximal end of a tarsometatarsus from Vancouver Island, in the family Cyphornithidae.

The dimensions of the MCZ tarsometatarsus are commensurate with the expected dimensions of this bone in a bird with a femur the size of the type specimen of *Palaeochenoides mioceanus* and with limb proportions approximating those of *Pelecanus* or *Diomedea*. Both fossil limb bones have very thin-walled shafts indicating that they were highly pneumatic. With the exception of the pseudodontorns, with which they cannot be compared in any detail because of the lack of comparable well-preserved parts, no other volant bird of this size is known from the Miocene of North America (*Cyphornis* is much larger). Therefore, it is extremely likely that the MCZ specimen is referable to *Palaeochenoides mioceanus*. Were it to show distinctly pelecaniform features, this assignment would be a virtual certainty; as it does not, I have qualified its reference to this species with a question mark. Further discussion of its relationships is left until the end of this paper.

The shaft of the tarsometatarsus is broadly oval in cross section, and is almost completely smooth except for a prominent, though damaged, longitudinal ridge on the anterior surface. This ridge terminates ventrally 17.5 mm above the inner edge of the middle trochlea. At its lower border, the shaft is 22.3 mm wide. The possible function of this structure is discussed below in connection with the second tarsometatarsus.

In anterior view the shaft is moderately expanded distally: in profile its sides are only slightly concave above the trochleae.

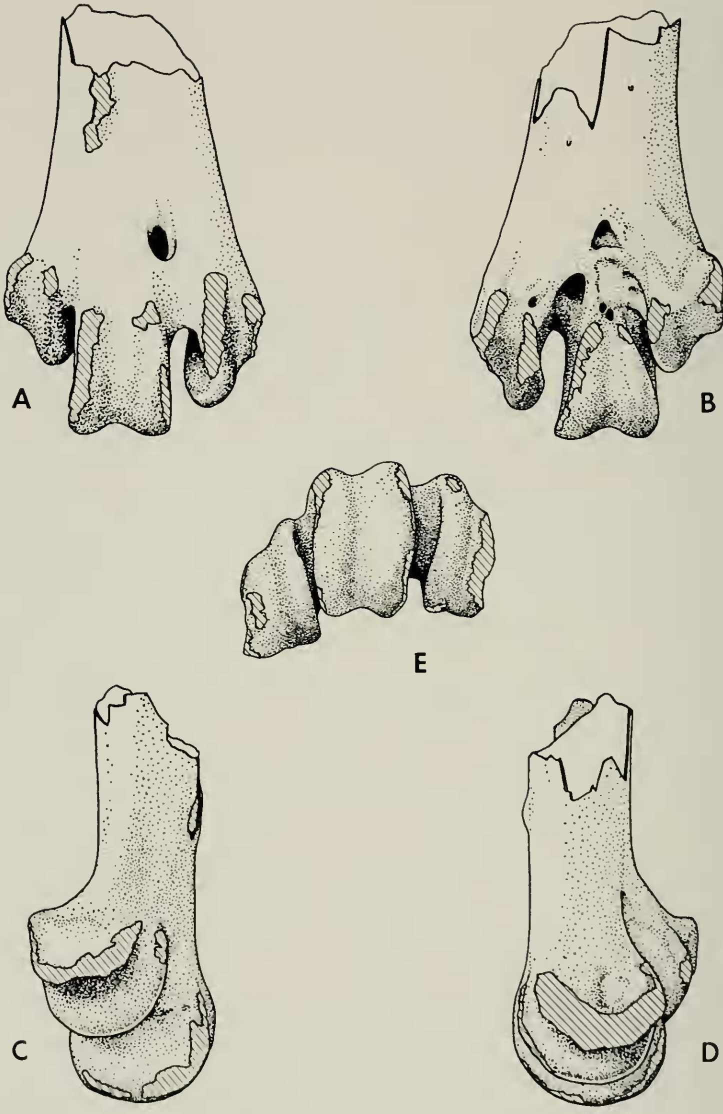

Figure 2. ?*Palaeochenoides mioceanus* MCZ 2514, left tarsometatarsus. A. Acrotarsial view. B. Plantar view. C. Medial view. D. Lateral view. E. Distal view. × 1.

The width through the trochleae is 34.7 mm. The middle trochlea is the longest of the three. It is relatively broad; the rims of the articular facets are relatively low with a broad shallow sulcus between them. The outer trochlea is 4 mm shorter than the middle one. Its inner rim extends well below its outer. Viewed laterally, its plantar wing extends slightly beyond, and its acrotarsial edge slightly below, the corresponding edges of the middle trochlea. The inner trochlea is elevated above the others and is thrust relatively strongly backward and slightly inward. The inner intertrochlear notch is about 2 mm deeper than the outer. In side view the acrotarsial edges of the middle and outer trochleae are raised only slightly above the level of the shaft.

Posteriorly, no articular facet for digit I is visible; therefore, this toe was absent or greatly reduced. The plantar surface of the shaft is slightly concave between the bases of the trochleae. Some 9 mm above the center of the middle trochlea, and 4 mm dorsomedial to the distal foramen, is a relatively large subtriangular pit, about 4 mm in maximum diameter, which passes obliquely dorsally into the shaft. It does not seem to be a pneumatic foramen for no comparable foramen was seen in any of those birds with pneumatic tarsometatarsi. The closest approximation to such a structure were one or more much smaller foramina in the same location seen in numerous members of a variety of orders. These foramina presumably mark the attachment areas of stout ligaments binding sesamoid bones in the living species, and perhaps the foramen in the fossil had a similar function.

Immediately below this foramen is a low ridge which passes ventromedially on to the lateral surface of the inner trochlea. This ridge forms the upper boundary of a pitted depression on the plantar surface of the intertrochlear space and the posteromedial surface of the base of the middle trochlea. A roughened scar on the outer half of the latter, which terminates distally at a pair of well-developed pits just above the articular surface, bounds the depression laterally. This rather prominent depression probably held a large sesamoid which was anchored in place by strong ligaments. A similar depression is described by Brodkorb (1963c) in the Cretaceous gaviiform *Lonchodytes*.

The distal foramen is low, the ventral margin of its acrotarsial opening being 4 mm above the articular surface of the middle trochlea. It is oval, of moderately large size, and oriented at a distinct angle to the axis of the shaft. Its plantar opening is between the bases of the middle and outer trochleae. The small foramen for extensor brevis digiti quarti passes from just inside the anteroventral end of the distal foramen to open distally between the middle and outer trochleae. A short faint groove for the extensor tendon passes upward from the outer half of the distal foramen for about 4.5 mm and merges into the surface of the shaft.

By far the greatest similarity of this specimen is to the procellariiforms. However, as *Palaeochenoides* was believed by Shufeldt (1916) to be allied to the anseriforms and by Wetmore (1917) to the pelecaniforms, it is also compared with members of these orders.

The rather broad, somewhat anteroposteriorly compressed, and smoothly rounded shaft is similar to that of *Diomedea*, and unlike either the similarly shaped but strongly ridged and grooved shaft of *Pelecanus* or the smooth but more slender and rounded shafts of the anseriforms. It is quite distinct from the extremely flattened shaft of *Sula*. The relative lengths of the trochleae are most nearly duplicated in the smaller procellariiforms, especially *Fulmarus*. In *Diomedea* the inner trochlea is nearly as long as the outer, while in the ducks it is generally quite short and very high on the shaft. In the pelecaniforms the inner trochlea is longer than the outer, and may, as in *Sula*, be the longest of the three. The alignment of the outer and middle trochleae in a transverse plane is seen only in the smaller procellariiforms; in *Diomedea* and in the other orders examined the outer trochlea has a moderate thrust toward the plantar surface.

In most features of the individual trochleae the fossil is very different from the pelecaniforms and most resembles the procellariiforms. The middle trochlea is broader than in *Diomedea*, and much broader than in the other members of the order, but the low rims of the articular facet separated by a broad groove are virtually identical to these features in the procellariiforms. In the pelecaniforms this articular facet is quite different.

having high swollen rims and a deep median groove. A distinctly grooved inner trochlea is also like the procellariiforms, and unlike the pelecaniforms in which the articular surface is rounded or very feebly grooved.

The absence of a facet for the first digit is like *Diomedea*, and unlike the pelecaniforms in which the facet is generally strongly developed. The strong ridge on the anterior face of the shaft is not found in any living form examined, though, as Dr. Alexander Wetmore *(in litt.)* has pointed out, a similar structure is faintly indicated in *Diomedea*.

The distal foramen is less like that of either the procellariiforms or the pelecaniforms than it is like that of the anseriforms, being very low, oblique, and opening posteriorly between the outer and middle trochleae. In general, it is lower in the pelecaniforms than in the procellariiforms, but it is more obliquely oriented in the latter. It differs from that of anseriforms in being flush with the anterior surface of the shaft, as it is in *Diomedea*, rather than being depressed in a shallow sulcus.

To summarize these facts, the MCZ tarsometatarsus is matched most closely in general shape and surface features by the comparable element in *Diomedea*, though in relative proportions of the trochleae it is almost identical to *Fulmarus*. It shows no distinctly pelecaniform, as opposed to procellariiform, features except an apparently strong pneumaticity. The only feature in which it most nearly resembles the anseriforms is the low, oblique distal foramen.

In addition, the specimen has several characters either completely lacking or only feebly developed in any of the above orders. These are: (1) the strong ridge on the anterior face of the shaft; (2) the prominent foramen on the plantar surface; and (3) the pitted depression between the plantar faces of the middle and inner trochleae. All of these features, apparently related as they are to tendons and sesamoids of the foot, suggest that the living bird had powerfully developed toes.

The possible relationship of *Palaeochenoides* to the pseudodontorns will be discussed in a final section after the description of the second tarsometatarsus from the phosphate beds.

Family CYPHORNITHIDAE?

***Tympanonesiotes*[3] *wetmorei*,**[4] new genus and species

Figure 3

Type: Distal portion of right tarsometatarsus, USNM 16809.

Horizon and Locality: Hawthorne Formation. From the Cooper River, near Drum Island, Charleston, South Carolina.

Diagnosis: Tentatively referred to the family Cyphornithidae on the basis of its similarity to the ?*Palaeochenoides mioceanus* tarsometatarsus (MCZ 2514), which it resembles in: its relatively broad flat shaft expanding gradually into bases of trochleae; relative proportions of its trochleae (as preserved); its low distal foramen opening posteriorly between bases of trochleae III and IV; short ridge on anterior surface of its shaft; pronounced hollow on plantar surface between trochleae II and III.

It is distinguished from *Palaeochenoides?* in: being about one fourth smaller in size; having distal foramen lower and contained in deep sulcus; having anterior surface of trochleae III and IV raised more abruptly and to a greater height above level of shaft. It is distinguished from *Cyphornis* by its much smaller size, from *Osteodontornis* and *Pseudodontornis*, less certainly, by its smaller size.

The specimen consists of the anterior face of the distal end of the tarsometatarsus with the basal sections of the three trochleae. The posterior surface with the exception of the base of the middle trochlea is missing.

The very thin wall of the shaft indicates that this element was pneumatic. The lower end of the shaft is relatively flat with the lateral portions gently rounded toward the back. Inside the median line of the shaft, about 15 mm above the upper

[3] From Greek *tympanon* (drum) and *nesiotes* (feminine, islander).

[4] Named in honor of Dr. Alexander Wetmore.

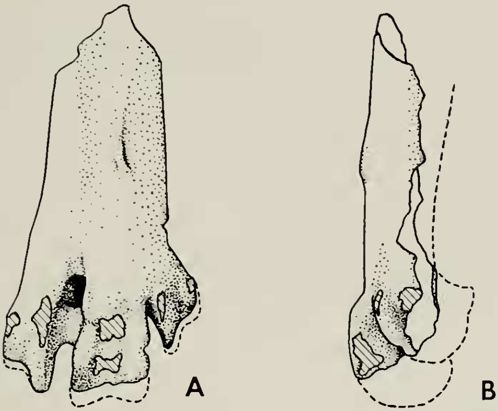

Figure 3. *Tympanonesiotes wetmorei* gen. et sp. nov., USNM 16809, right tarsometatarsus. A. Acrotarsial view. B. Medial view. ×1.

edge of the middle trochlea, are a pair of short ridges which form a narrow sulcus between them. The more medial is a heavy ridge some 8 mm long which corresponds to the similar raised area on the shaft of the *Palaeochenoides*? tarsometatarsus. The outer raised line is very faint in *Tympanonesiotes* and is not evident at all in the larger specimen. The sulcus, according to Dr. Wetmore *(in litt.)*, "evidently guided a tendon that controlled the inner toe. The indication, therefore, is that the rather elevated second toe was capable of active movement." The width of the shaft at the base of the heavier ridge is 16.1 mm.

The outer two trochleae lie in the plane of the shaft. The inner is inflected slightly posteriorly, and is elevated above the level of the other two, its upper margin being on a line with the upper margin of the distal foramen. Details of the trochleae, insofar as they are preserved, are nearly identical to these parts in the MCZ specimen. In *Tympanonesiotes* the anterior surface of the middle and outer trochleae are raised more sharply above the level of the shaft. The preserved width through the trochleae is 24.5 mm.

The distal foramen is contained in a shallow sulcus with a short groove presumably for extensor brevis digiti quarti, extending upward for 5 mm to merge with the surface of the shaft. Below the distal foramen the sulcus deepens, extending between the middle and outer trochleae. Possibly the extensor tendon lay in this sulcus rather than having been enclosed in a distinct foramen, the presence or absence of which cannot be determined in this specimen.

Enough of the plantar surface is preserved to show that the distal foramen opens posteriorly between the bases of the middle and outer trochleae. On the inner half of the middle trochlea, continuing into the intertrochlear space, is a roughened depression like that seen in *Palaeochenoides*?. It is bounded above by a shelf passing upward and outward from the inner trochlea to the extreme base of the middle trochlea.

In his notes Dr. Wetmore writes: "The only hint of possible relationship that has come from this latest study is a faint resemblance to what is found in the albatrosses." Mainly on the basis of the more complete MCZ specimen I had also arrived at the similar conclusion that the closest resemblance of these two tarsometatarsi is to *Diomedea*. The *Palaeochenoides*? bone, however, is in general less specialized and more albatross-like than is that of *Tympanonesiotes*.

RELATIONSHIPS OF THE PHOSPHATE BEDS BIRDS

With regard to the possible ordinal relationships of the two tarsometatarsi described above, the following conclusions may be drawn: (1) they show definite resemblances to the Procellariiformes except for being highly pneumatic; (2) they show no definite resemblances to the Pelecaniformes, with the exception of an apparently high degree of pneumaticity; (3) the larger specimen resembles in size and pneumatic character a femur, the type of *Palaeochenoides mioceanus*, from the same formation and a nearby locality, which, however, is distinctly pelecaniform and not procellariiform in morphology; and (4) *Pseudodontornis longirostris*, a large bird comparable in size to *P. mioceanus* and a member of a family which shows a combination of pelecaniform and procellariiform features also occurs in the same beds as all of the above-mentioned specimens. It therefore seems probable that *Palaeochenoides* and *Pseudodontornis* are synonymous (the former name having priority).

Unfortunately, confirmation of this hypothesis by comparing the Hawthorne limb bones with the type skeleton of *Osteodontornis* cannot yield conclusive results for the leg bones of that specimen are so crushed that none but the grossest features can be made out with any certainty. However, Howard (1957) does note the probable absence of digit I in this specimen, a point of similarity to ?*P. mioceanus* and a distinct difference from the pelecaniform birds. Inasmuch as the evidence suggesting the identity of *Palaeochenoides* and *Pseudodontornis* is as yet by no means conclusive, I await further knowledge of well-preserved associated skeletal parts before proposing formal nomenclatural changes.

In recent classifications (Wetmore, 1960; Brodkorb, 1963b) the pseudotoothed birds have been placed as a suborder of the order Pelecaniformes. Howard (1957), however, as a result of her study of the relatively complete skeleton of *Osteodontornis* concluded that the three genera of "toothed" birds show enough similarities to both the Pelecaniformes and Procellariiformes in combination with quite distinctive characteristics of their own to merit placement in a separate order Odontopterygiformes (proposed by Spulski, 1910, as Odontopterygia). Wetmore (1960), on the basis of a restudy of the skull of *Odontopteryx*, prefers to retain the group in the Pelecaniformes. If the Hawthorne tarsometatarsi do pertain to pseudodontorns they strengthen Howard's argument that the odontopterygians show enough non-pelecaniform features to require being placed in an order of their own.

Whether or not the Odontopterygia should be raised to the status of order, I suggest that the family Cyphornithidae be added to its included families (see Brodkorb, 1963b, for the most recent classification of this group). This allocation of the Cyphornithidae, in which I would include *Cyphornis*, *Palaeochenoides*, and, less certainly, *Tympanonesiotes*, is necessarily provisional, but it is preferable to that of Brodkorb (1963b), in whose classification this family is placed in the suborder Cladornithes. This possibly pelecaniform suborder was erected by Wetmore (1960) to contain *Cladornis pachypus* Ameghino (1895), a peculiar broad, anteroposteriorly compressed tarsometatarsus from the Oligocene of Patagonia. Brodkorb's reason for including the Cyphornithidae in the suborder Cladornithes was the presence in the same beds with *Palaeochenoides* of the tarsometatarsus described herein as *Tympanonesiotes wetmorei* (USNM 16809), which he believed bore a resemblance to Ameghino's figure of *Cladornis* (Brodkorb, pers. comm.). With additional preparation and with the more complete MCZ tarsometatarsus taken into account, it is clear that *Tympanonesiotes* is quite different from *Cladornis* and sheds no light whatsoever on the possible affinities of the Patagonian fossil. The suborder Cladornithes is best returned to its uncertain position at the end of the order Pelecaniformes, where it was placed by Wetmore (1960).

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